European Post Licensing Advanced Driver Training Programs: Why the US Should Pay Attention

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Post license advanced driver training programs in the US and early programs in Europe have often failed to accomplish their stated objectives because, it is suspected, that drivers gain self perceived driving skills that exceed their true skills—leading to increased post training crashes. The consensus from the evaluation of countless advanced driver training programs is that these programs are a detriment to safety, especially for novice, young, male drivers.

Some European countries including Sweden, Finland, Austria, Luxembourg, and Norway, have continued to refine these programs, with an entirely new training philosophy emerging around 1990. These 'post-renewal' programs have shown considerable promise, despite various data quality and availability concerns. These programs share in common a focus on teaching drivers about self assessment and anticipation of risk, as opposed to teaching drivers how to master driving at the limits of tire adhesion. The programs focus on factors such as self actualization and driving discipline, rather than low level mastery of skills. Drivers are meant to depart these renewed programs with a more realistic assessment of their driving abilities. These renewed programs require considerable specialized and costly infrastructure including dedicated driver training facilities with driving modules engineered specifically for advanced driver training and highly structured curriculums. They are conspicuously missing from both the US road safety toolbox and academic literature. Given the considerable road safety concerns associated with US novice male drivers in particular, these programs warrant further attention.

This paper reviews the predominant features and empirical evidence surrounding post licensing advanced driver training programs focused on novice drivers. A clear articulation of differences between the renewed and current US advanced driver training programs is provided. While the individual quantitative evaluations range from marginally to significantly effective in reducing novice driver crash risk, they have been criticized for evaluation deficiencies ranging from small sample sizes to confounding variables to lack of exposure metrics. Collectively, however, the programs sited in the paper suggest at least a marginally positive effect that needs to be validated with further studies. If additional well controlled studies can validate these programs, a pilot program in the US should be considered.

Keywords: Driver education, motor vehicle safety, advanced driver training programs, insight based training, teen drivers, novice drivers

Novice Drivers in the US—A Persistent and Significant Road Safety Concern

Novice teen drivers are a group of particular concern in the US due to their significantly elevated safety risk. Teens are thought to be immature, inexperienced, and are more risk and sensation seeking compared to older drivers. They are also less likely to wear safety restraints and more likely to speed, drive late at night, drive impaired, and transport teenage passengers (NTHSA, 2008b).

According to NHTSA (2007), 6,851 drivers aged 16 to 20 were involved in fatal crashes in 2007. Eighteen percent of them had blood alcohol levels exceeding 0.08. Drivers aged 15 to 20 have the highest proportion fatal crashes associated with speeding (39% of males and 24% of females) (NHTSA, 2007).

Trends in 2008 were similar. In the 16 to 20 year old age group, 4,497 persons were killed, 42,000 had incapacitating injuries 111,000 had non-incapacitating injuries, and 205,000 had other injuries, for a total of about 363,000 persons injured or killed (NHTSA, 2008a). Figure 1 shows population-based risk by age and gender for fatalities and injuries.

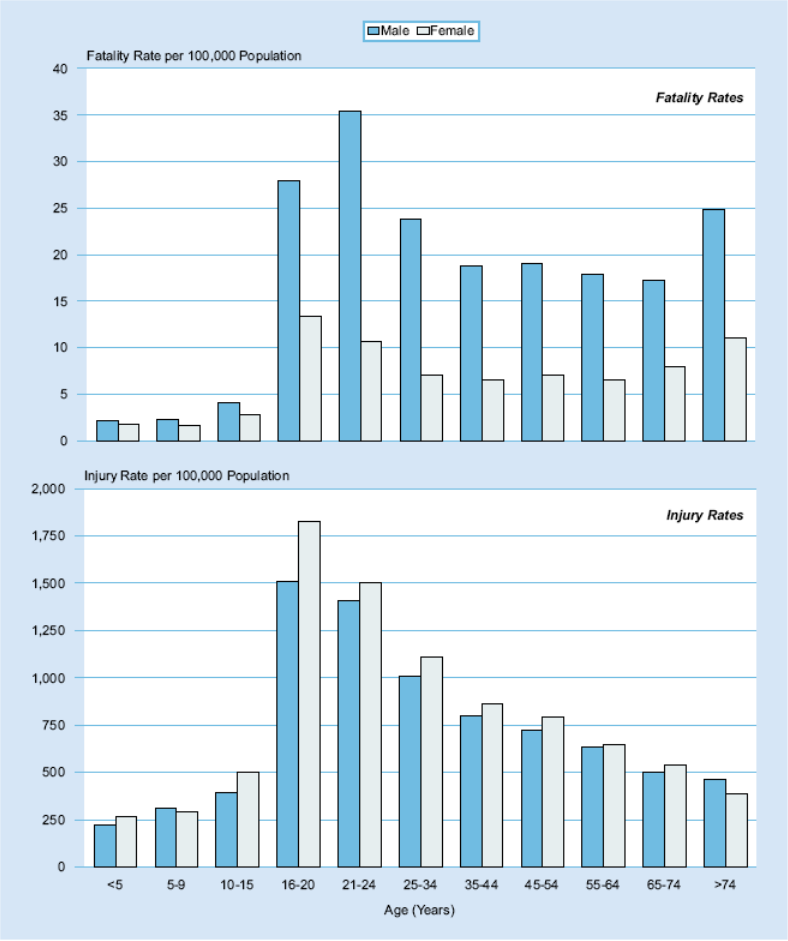

Figure 1: Fatality (top) and Injury (Bottom) Rates per 100k Population by Age and Gender (NHTSA, 2008a)

Several features of this figure are striking. First, 16 to 20 year olds have the highest crash rate for injuries and second highest rate for fatalities. Second, females (shown in white) have higher injury rates than males, in all age cohorts except 5-9 and 74+. Finally, males have significantly higher fatality rates than females across the board, most significantly for the 16 to 24 age cohort. The figure emphasizes the need to address novice driver safety in the US.

Young drivers engage in risky behaviors. In 2008, 54.8% of all occupants (aged 16 to 20) killed in passenger cars or light trucks were not wearing safety restraints, while only 10.5% of the injured occupants were not wearing restraints. In addition, about 17% of drivers and motorcycle riders in this same age cohort had BAC levels of 0.08 or greater, but 22% had some amount of alcohol on board (NHTSA, 2008a).

Clearly, young inexperienced drivers in the US represent relatively large crash risk compared to other driving groups, and engage in risky behaviors such as speeding, drinking and driving, and failure to wear safety restraints. For obvious reasons, focusing effective road safety programs on these drivers, including licensing, driver education, and post licensing programs should remain a priority. While much has been written elsewhere on licensing and driver education (see for example NHTSA, 2009), this paper focuses on the predominant features and empirical evidence surrounding post licensing advanced driver training programs focused on novice drivers Literature Review on Post-Licensing Advanced Driving Training Programs.

Numerous reports provide extensive reviews of the literature on various aspects of advanced driver training (ADT) programs, both nationally and internationally (e.g. Austrian Road Safety Board, 2000; Christie, 2001; European Commission, 2007; NHTSA 2009). The body of evidence is overwhelmingly against their effectiveness in producing safer young drivers. The intent here is not to replicate these reviews, but instead to highlight the general conclusions from them and to identify critical 'gaps' that may give cause for optimism and opportunity. The research gaps and cause for optimism described in this section is not the result of poor research, rather it is largely the result of years of ineffective approaches to ADT and overwhelming evidence that these approaches have failed. It is apparent the result is surrender of a belief that ADT programs can be made effective.

To set the stage for this literature review, the literature can be divided between pre-renewal and post-renewal, post-licensing ADT programs. 'Renewal' refers to a time period in several European countries starting around 1990, when advanced 'skills mastery' focused programs were discarded in favor of 'insight' and 'awareness' based training. The intent is to provide young drivers with insight into their inherent physical and mental limitations and awareness as to the limitations of their vehicle. This paradigm shift is critically important when considering the literature on ADT because it defines a time period (circa 1990) where prior studies revealed overwhelming evidence against their effectiveness. Post-renewal studies, which are few in number, suggest promise and optimism. Moreover, many countries, including the US, have not made a paradigm shift to insight based ADT; thus, they are shadowed by continued, overwhelming evidence against their use for improving road safety.

The most recent comprehensive review of US driver education and post licensing programs was conducted by NHTSA (2009). Numerous critically important statements made in this report set the stage for the post-renewal ADT programs. In the section titled "Why Driver Education Does Not Produce Safer Drivers", the authors make several important and insightful conclusions:

> "The courses generally are of short duration, and most of the time has to be spent teaching basic vehicle handling skills. This leaves less time to try to teach safe driving skills."
>
> "Probably the biggest impediment to driver education effectiveness involves the inherent difficulties in affecting lifestyle and developmental factors: the attitudes, motivations, peer influences, and cognitive and decision-making skills that are so influential in shaping driving styles and crash involvement."
>
> "Another way driver education can worsen the problem is through courses that unintentionally encourage risky driving. Specifically, courses that teach advanced driving maneuvers can produce adverse outcomes. These courses are currently very popular in the United States as a way to supplement basic driver education. The courses are generally taught by police or in advanced driving schools using test track facilities."

The authors, of course, are entirely correct and pinpoint the basic issues of all current US driver education and training programs. On the final quote regarding ADT programs in the US, the authors cite four studies published between 1982 and 1995 demonstrating young males who take these courses reveal worse safety records than control groups of drivers who do not take the courses.

NHTSA (2009) points to Christie as the authoritative study on ADT courses and their impact. Christie's report allocated half a page to summarize the evidence on ADT studies, and cited 3 reports conducted between 1974 and 2000. Christie (2001) states in the conclusions: "There is also considerable evidence that driver training that attempts to impart advanced skills such as skid control to learner drivers may contribute to increased crash risk, particularly among young males. This pattern of results has been confirmed and replicated across numerous studies conducted in Australia, New Zealand, North America, Europe, and Scandinavia during the last 30 years." While the statement is in this report, no references to these studies are included in the section on ADT. While not cited, it is a certainty that these studies confirm what others have found -- 'mastery of skills' based courses are a detriment to road safety.

Christie also cites a 'study' by Lord (2000), a non peer reviewed article published in Wheels Magazine, "…no-one has come up with an evaluation that shows there's a benefit to advanced skills training…gains from training may be offset by confidence and reduction of safety margins…". This evidence is not surprising, as the study pre-dates the post-renewal paradigm shift, and reinforces the notion that skills mastery training does not improve road safety for the participants.

Finally, Christie refers to a study by Williams and O'Neill (1974) where the crash and violation records of 3000 members of the Sports Car Club of America who held race licenses in Florida, Texas, and New York (with presumably very good driving skills) were compared to a non-racing

drivers matched on socio-demographic factors. The study reveals statistically significant higher levels of on-road crashes and violation records. Christie also sites his prior study published in 1991 summarizing the effects of ADT programs as detrimental to safety. This study also sites pre-renewal skid based training in Europe and, not surprisingly, showed detrimental effects to safety.

Another NHTSA study focused on teen drivers (NHTSA, 2008b) states, "It was once thought that effective driver education and training would reduce high crash rates of young, novice drivers. Historically, driver education in the United States has taught basic driving skills and safe driving practices. Many carefully conducted studies of driver education in the United States and abroad have failed to provide evidence for decreased crash rates among teen drivers who have participated in driver education programs." The report then sites five studies published between 1985 and 2004 documenting failed US driver education programs.

It is important to highlight a few influential studies in Europe. A study by Glad (1988) concluded skid based training in Norway was unsuccessful, given that participants in a before after comparison showed increased crashes on slippery roads. Glad interpreted this effect as the result of training which focused on coping with skidding situations instead of teaching how to avoid them. Participants may believe they can overcome dangerous situations and make no effort to avoid them. A review of programs in German speaking countries (Fastenmeier & Gstalter, 1999) concluded that no programs had yet revealed crash reducing effects. Siegrist and Ramseier (1992) also reported a zero-effect on crashes of safe driving courses in Switzerland. Finally, a study by Katila et al. (1999), submitted to Accident Analysis & Prevention in 1995, prior to the renewal training, concluded that efforts to use slippery roads training in Denmark, Finland, Norway, and Sweden have generally failed. Again, the conclusion is "Maneuvering exercises also increase their self-confidence and may lead to underestimation of risk involved, resulting in e.g. driving at higher speed".

These reviews in Europe and the US point to an overwhelming conclusion -- teaching drivers to improve skills such as high speed braking and cornering serves only to increase driving confidence to the point of decreasing road safety. It is likely that these drivers, on average, engage in riskier behavior after such training, and become less risk-averse drivers. These programs also may produce drivers that perform maneuvers too aggressive for less "skilled" drivers on the road. For example, a trained driver may be able to threshold brake (stopping on the threshold of skidding) in traffic which results in a rear-end crash with a following non-trained driver. Moreover, the focus exclusively on the mastery of skills of all ADT programs in the US and all international programs prior to 1990 has led to a large number of evaluations revealing a detriment to safety. It is not surprising, given this evidence, that the road safety profession has mostly abandoned advanced driving training programs as a road safety solution.

Post-renewal Advanced Driver Training Programs: A Paradigm Shift

Some innovative Europeans were discouraged by the evaluation results of early advanced driving training programs. Around 1990, they started to re-think these programs. The programs represented a significantly revised philosophy on how to train novice drivers, with explicit recognition of the

shortcomings of pre-renewal programs. The next section describes and illustrates critically important aspects of these new philosophies are described and illustrated.

The general post-renewal approach to ADT is shown in Figure 2 (Austrian Road Safety Board, 2000). The left half of the diagram shows the intended outcome of training on the inexperienced high risk driver, while the right half of the diagram shows the intended training effect on the inexperienced insecure (timid) driver. The objective measure of driving skills (stopping distance, reaction time, reaction sequence, etc.) are shown in yellow, while the self perceived driving skills are shown in orange. The bottom figures show the desired effect of post-renewal training, while the top figures show the documented effect of pre-renewal driver training programs, used in Europe through the 1990s and currently used in the US. Current programs increase skills but also increase self perceived skills. The post-renewal philosophy is to improve the actual skills of the potential high risk driver while reducing their self perceived skills (remove overconfidence). For the timid inexperienced driver, the training increases both skills and self confidence.

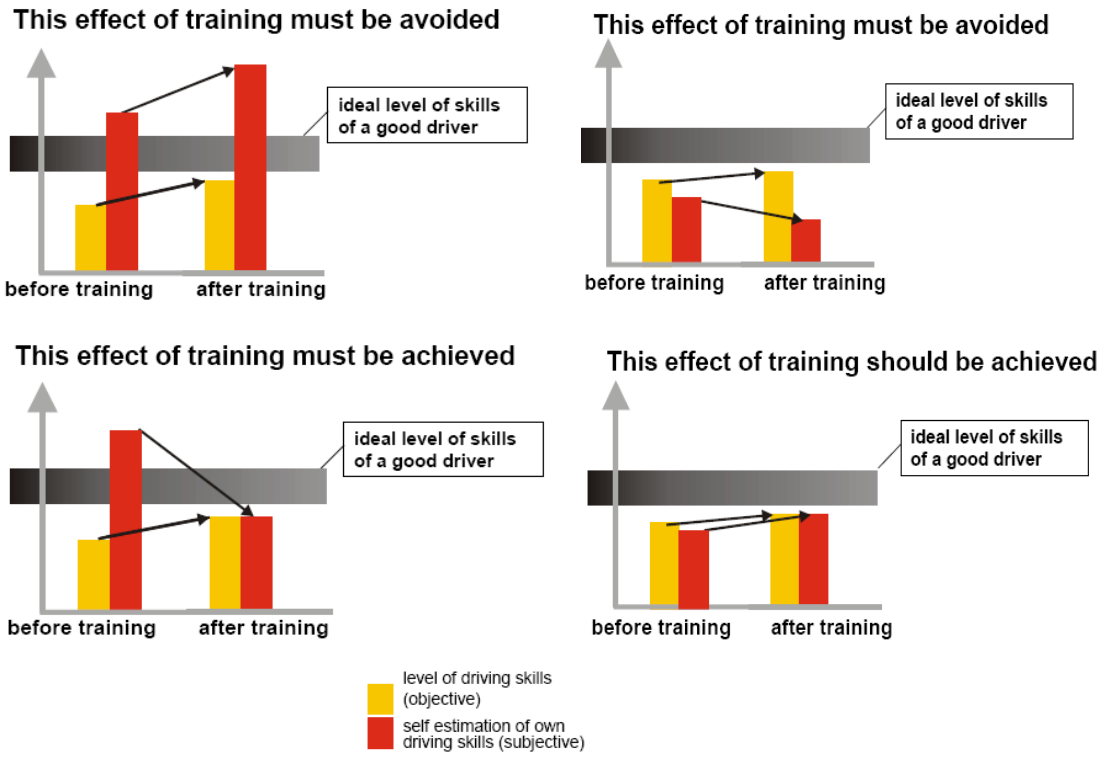

Figure 2: Post-renewal Advanced Driver Training Philosophy. Inexperienced high risk driver (left); Inexperienced timid driver (right). (Austrian Road Safety Board, 2000)

Figure 2 depicts the "overconfident" and "timid" groups as targets for training and as identified by Gregersen and Berg (1994). This training philosophy is also consistent with the testing described by Gregersen (1996), whereby students taught with emphasis on skills evaluated their self perceived

skills much higher than a group using 'insight' based training. Their actual skills were not statistically different, yet their self perceived skills were significantly different. A more recent study by Rosenbloom et al. (2007) tested 224 individuals using training that emphasized dangers in drivers using skid-based training. The study showed higher levels of perceived risk were present two months after the training and the perceptions had not decreased significantly since immediately after the training.

An excellent description of this change in philosophy is described in relation to the Swedish advanced driving training program (Austrian Road Safety Board, 2000):

> "The learner driver shall, after the education, achieve increased insight in the advantages of avoiding risks and has the opportunity to realistically assess his/her driving skill."

How might this new philosophy look to a student? A typical renewed advance driver training program takes place at a dedicated driver training facility that includes a road course with slick pavement (i.e. water systems, and application of specialized road surface materials), classroom instruction, and between 10 to 15 students per instructor. The instructor interacts with students remotely, communicates by radio, and instructs students driving their own vehicles through a road course configured to make students pass the threshold of control in a safe manner. By design, loss of vehicle control occurs sooner and at slower speeds than students anticipate, and loss of control lasts much longer than anticipated. The instructors make it difficult for the student to actually control their own vehicle by manipulating certain aspects of the driving environment. This is intended to accomplish a number of things. Over-confident students become challenged to succeed, as they strive to gain control of their own vehicles. Learning to avoid loss of control requires repetition, and the repetition often requires drivers to enter the course slower each time to avoid loss of control.

Because instructors know the threshold speed for a vehicle on the track and are monitoring students remotely, they are able to observe student mistakes. Instructors use the environment creatively to force students to make mistakes and reinforce loss of vehicle control. Students often over-react, which sends their vehicles into unrecoverable spins.

In theory students learn to control their vehicles properly and avoid dangerous situations altogether because the instructors and the students themselves can analyze mistakes effectively ~~and avoid loss of control~~. Timid drivers are thought to increase their confidence through this same repetition. Pre-renewal methods such as those provided in the US are thought to intimidate timid students, as speeds are very high and vehicle maneuvers can be dramatic and forceful. This type of training in the US, as described by the European pedagogy (see Figure 2), reduces confidence and may lead to situations where frightened student drivers over-react prematurely or freeze. Post-renewal programs address this issue by enabling loss of control safely and at relatively low speeds to foster understanding of the situation that resulted from driver actions. In addition, loss of control happens at a slower pace than at high speeds, so students experience the sensations and process their inputs and reactions more effectively. Students are thought to learn not only how to avoid dangerous

situations altogether, but more importantly reasons for avoiding them. The dedicated driver training facilities required to support post-renewal driver training practices consistent with this pedagogy do not exist in the United States.

Post-renewal Advanced Driving Training Programs: Examining the Empirical Evidence

Some of the empirical results and program details across several countries with post-renewal ADT programs are discussed in this section. In summary a consistent theme emerges, whereas the studies reveal marginal or significant benefits of the ADT programs; however, the individual studies are flawed for one reason or another, and further study is needed to validate the findings described here.

Austria

Austria has played an integral roll in the development and application of post-renewal ADT programs. Many of the European countries embracing post-renewal ADT already had strict graduated drivers license (GDL) programs in place including Austria. These programs continue to be more restrictive than US programs. For example, Austria requires drivers to undergo a two-year probationary period prior to earning an unrestricted driver's license. Post-renewal ADT had also been available to novice drivers for over a decade in Austria. However, these programs were not mandatory. Ongoing reports monitored by the Austrian Ministry of Transportation indicated that the leading cause of accidents among teenage drivers remained single car accidents such as collisions with trees, etc. This high risk group of 18 to 20 year old drivers was also less likely to attend compulsory ADT programs and clearly strict GDL practices where not sufficient. As a result, Austria started developing a multi-phase driver licensing program and made ADT mandatory in 2003 for all learner drivers, who are 18 in Austria (Bartl and Esberger, 2005).

The multi-phase driving license program consists of a safe driving course, psychological group discussion, and two feedback drives with a driving school (advanced driving) in the first year after gaining the license. The 'second phase training' includes a skid based ADT course, designed and administered using the post-renewal philosophy and dedicated driver training facilities. The first full observation year for young drivers in this program was 2004. A limitation of the study was a lack of control for exposure, namely license holders or mileage driven (European Commission, 2007). This omission does not mean crash reductions were not realized, but rather possible confounding factors could have influenced the results.

Table 1 shows the suspected impact of this program on drivers subjected to the program, compared to 'other' car drivers in Austria. Analysis showed a reduction of 5.5% reduction in killed or injured 18 year old drivers in 2004, compared to the previous year, while other age categories of drivers killed or injured reduced by 0.4%.

A more detailed analysis comparing crashes during the first half of 2003 (e.g., prior to the mandatory program was in place) to the first half of 2004 and 2005 are also quite convincing (see Table 2). Compared to the reference group of all other Austrian drivers where crashes dropped by 2.1%, personal injury crashes among 18 and 19 year olds involved in the program decreased by 11.2%.

Note that the sample sizes are not small; the reference group had 22,558 crashes in the first half of 2003 and 22,077 in 2005.

Table 1: Car Crashes in Austria Resulting in Injured or Killed Drivers, 2000 to 2004

	18 year old car drivers		Other car drivers	
	Absolute figures	Change %	Absolute figures	Change %
2000	1155		22115	
2001	1256	*+8.7%*	23675	*+7.1%*
2002	1221	*-2.8%*	23790	*+0.5%*
2003	1235	*+1.2%*	23804	*+0.1%*
2004	1167	***-5.5%***	23706	***-0.4%***

Source: Statistik Austria / Institut Gute Fahrt

Table 2: Eighteen and Nineteen Year Old Drivers in Austria Involved in Crashes Causing Personal Injury

	18 and 19 year old car drivers		Other car drivers	
	Absolute figures	Change %	Absolute figures	Change %
1. half year 2003	2135	.	22558	.
1. half year 2004	2086	*-2.3%*	22831	*+1.2%*
1. half year 2005	1896	*-9.1%*	22077	*-3.3%*
Change in first half of year 2003/2005		*-11.2%*	-	*-2.1%*

Source: Statistik Austria / Processing: Institut Gute Fahrt

Finland

Finland introduced a compulsory 2nd phase of driver training in 1990 (Austrian Road Safety Board, 2000). In 1996 Finland introduced a follow up system for drivers with traffic violations. All drivers in Finland take the 2nd phase of driver training within 6 to 24 months after obtaining a driver license. If 24 months lapses without taking the 2nd phase of training the license is suspended. The program

consists of skills training for interaction in traffic, active learning methods (learning while doing), and is implemented through analysis, track time at dedicated driver training facilities, and in a classroom. Additional details of the Finnish program can be found in the report by the Austrian Road Safety Board (2000).

The theoretical underpinnings of the Finnish system consist of cognitive, hierarchical theories of driving behavior (Mikkonen and Keskinen, 1980; Keskinen, Hatakka and Katila, 1992; Keskinen, 1996) and constructive learning, as depicted in Figure 3. Driver behavior is described as a hierarchy, where driving tasks are divided into components consisting of basic maneuvering (the lowest level of the hierarchy) to general goals for living (the highest level of the hierarchy). Factors most important for road safety are located on the highest level of the hierarchy, i.e. "goals for life and skills for living".

Figure 3: Finnish Model of Post Licensing Advanced Driver Training (A. Katila, M. Peräaho, E. Keskinen, M. Hatakka and S. Laapotti, 2000)

The aim of the new curriculum was to develop driver skills with an emphasis on higher level skills, e.g. anticipating. The slippery road courses facilitate this approach. To avoid the negative effects of overconfidence as described by Glad (1988), Christensen and Glad (1996), and numerous other studies, emphasis of the program is on safe driving strategy in contrast to vehicle maneuvering skills (see Katila, Keskinen and Hatakka, 1999).

The pedagogical approach is fundamentally different than pre renewal ADT programs. Driving is treated not merely as a technical task, but something connected with drivers' own motivational mental structures. Traditional teacher-centered training methods are not sufficient. Novice drivers lack not only basic knowledge of traffic laws, but also the skills necessary to self evaluate motives and factors that affect driving. To accomplish a change in the mental patterns, thoughts, and ultimately behavior of drivers, the driver is provided with driving experiences and allowed to reflect upon these experiences, often repeatedly. Another central pedagogical idea is that drivers must be mostly self-taught; they must learn by doing and experiencing how external forces affect their vehicle during loss of control, and not through classroom instruction alone. This learning process is

more effective during the second phase of driving, or post license, and as such is preceded by a 6-24 months of independent driving so students have time to form opinions about driving, their own motivations, experiences, etc.

In a short term evaluation the program in Finland did not reveal significant results (Keskinen et al., 1992). When exposure was considered, crashes remained constant before and after the program. The proportion of crashes on slippery conditions increased in young male and female groups but decreased for drivers over 21. As a result of this initial study the educational materials were radically improved and further ADT instructor training was launched.

A longer term evaluation of the Finnish advanced driving training program revealed more optimistic results (A. Katila, M. Peräaho, E. Keskinen, M. Hatakka and S. Laapotti, 2000). The federal insurance company's database of all traffic crashes in Finland that resulted in at least material damage and reported to insurance was used to support the analysis. Only drivers determined to be at fault were considered in the analysis. While most of the reported crashes were property damage only crashes, it is recognized that if pre-and post- renewal programs suffered from differential reporting (i.e. PDO crashes were reported more or less pre and post-renewal), results could be skewed. It is assumed, however, that the new program did not materially influence the reporting of crashes to the federal insurance company.

The research team examined crash trends over time for all drivers compared to drivers in the 2nd phase program, with novice drivers separated into their first through fourth years of driving after the training. Figure 4 shows the crash trend of all drivers (darkened boxes) decreased over the seven year period. First year at fault novice drivers in reported crashes decreased from about 140 to about 80 crashes per 1000 driving licenses (43% reduction), whereas all drivers decreased from about 39 to 25 over the same period—a 36% reduction. In 1990 novice first year drivers had about 3.6 times the crash risk. By 1995, the risk was reduced to about 3.2 times. Second, third, and fourth year drivers that went through the program had larger improvements than first year drivers.

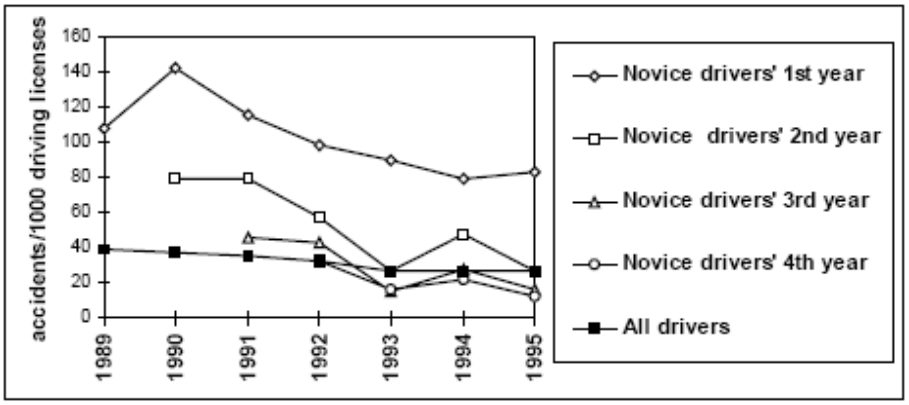

Figure 4: Crash trends of all drivers and novice drivers by driving year after participating in renewed advanced driver training program (A. Katila, M. Peräaho, E. Keskinen, M. Hatakka and S. Laapotti, 2000)

The program shows a dramatic effect when reported at fault crashes on slippery roads are compared among males (Figure 5) especially for 21 year old males, which revealed a statistically significant 76% reduction in crashes. The differences for 18-20 year old males and 21+ year old females were also statistically significant. For all program participants the slippery road crashes decreased about 23% from 1990 to 1995, while the number remained constant for the general driving population over this same time period (A. Katila, M. Peräaho, E. Keskinen, M. Hatakka and S. Laapotti, 2000).

Figure 6 shows nighttime crashes also revealed similar reductions. Statistically significant reductions in night time crashes occurred for all comparison groups except 21+ aged females. (Really?). During the period 1991 to 1995, the proportion of night time crashes increased in the general population by 15%, making young driver crash reductions even more impressive (A. Katila, M. Peräaho, E. Keskinen, M. Hatakka and S. Laapotti, 2000).

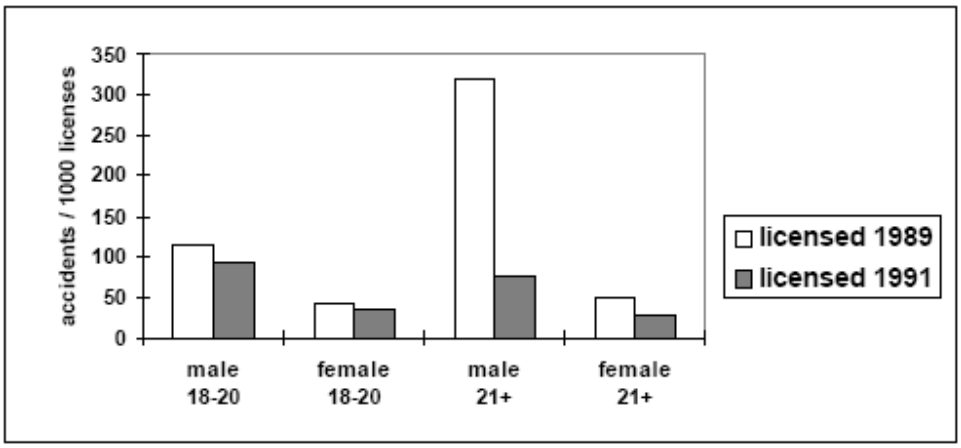

Figure 5: Slippery Road Crashes for Pre and Post-renewal Drivers Compared (A. Katila, M. Peräaho, E. Keskinen, M. Hatakka and S. Laapotti, 2000)

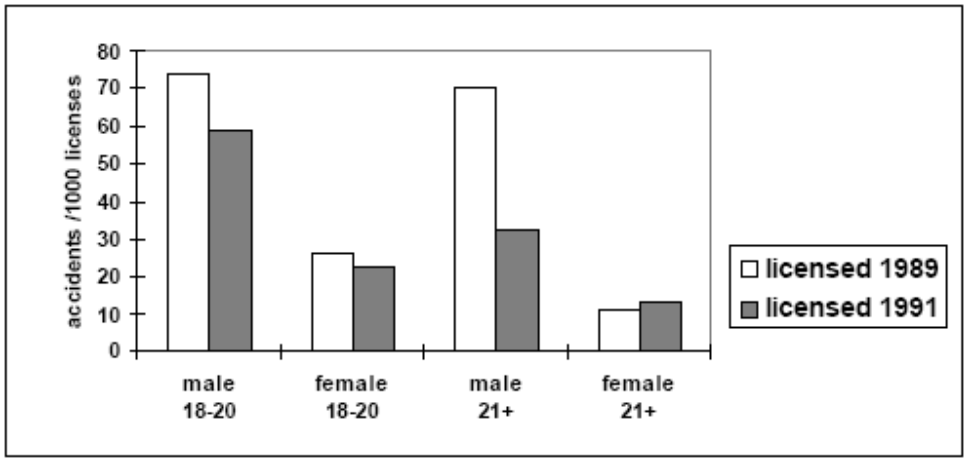

Figure 6: Night time Crashes for Pre and Post-renewal Drivers Compared (A. Katila, M. Peräaho, E. Keskinen, M. Hatakka and S. Laapotti, 2000

In addition to demonstrated reductions in crashes, male participants reported lower perceived crash risk and evaluated their personal skills as higher. They had more often sped and more rarely escaped a dangerous situation. Females reported being less worried about night time driving, slippery roads, long journeys, and risky situations on the road. Females also reported having sped more often, driven too closely behind another car, and had more often driven while hung over or tired. These responses seemed counter to the crash results. The authors expressed concern that drivers may still be appraising their own driving skills as higher than actual. These findings suggest that further work is needed to understand the relationship between perceived and actual skills of these programs.

The European Commission (2000) expressed concern regarding the inability to isolate the effects of slippery track training from the parallel changes to licensing. The overall trend of reduced crashes in the country was also noted. However, one can say that the combined effect demonstrated a positive effect of this program.

Luxembourg

A mandatory second phase of driver training called "complementary practical training" to prolong the educational supervision of novice drivers was implemented in Luxembourg and started in June of 1996 (Pannacci and Margue, 2000). Police reported fatal crashes between 1993 and 1999 were analyzed to support the evaluation of the program. The European Commission (2000) commented again about the joint implementation of several program changes at the same time, rendering isolation of effects difficult. However, the positive benefit of the entire program is noted.

On average the 18-24 year old age group of drivers in Luxembourg account for about 30% of all fatal crashes, followed by the 25-30 age bracket which is responsible for about 25%. From the average of the three years prior to the program (1993 to 1995) to the average of the three years after the program (1997 to 1999), fatal crashes reduced by 24.2% (Pannacci and Margue, 2000), undoubtedly caused by numerous factors including economic, weather, and the program. For the 18-24 age group affected directly by the training, a 37.28% reduction occurred over this same period, suggesting roughly 13% was due to the advanced driving training program.

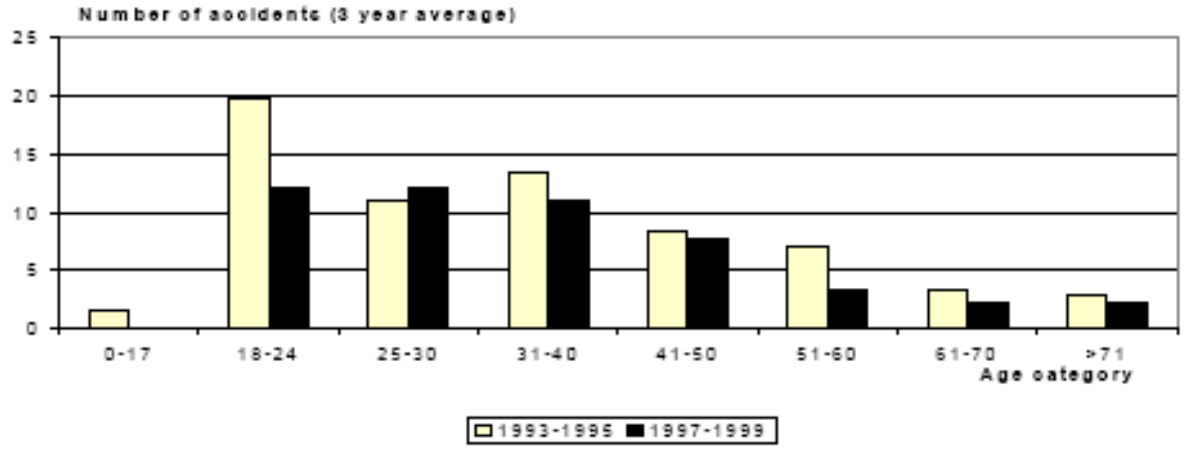

Figure 7: Three year average crashes by age group in Luxembourg pre (yellow) and post (black) advanced driver training program (Pannacci and Margue, 2000)

While the percentage drop is largest for the 51-60 age cohort, the sheer number of crashes is very small in this category. Overall the absolute numbers are small and so the three year average is important to reduce the effect of randomness from year to year. Clearly, however, the target age group appears to have benefited from the mandatory program in Luxembourg based on police crash reports.

Surveys also were administered to all novice drivers who participated in the course at the end of the two year probationary period. Surveys were collected from May to the end of October, 1999, and they yielded 1321 interviewed novice drivers including 638 males and 683 females. Of the total novice driver sample, 17.2% reported having at least one crash prior to the training and 13.8% at least one crash after the training (Pannacci and Margue, 2000).

Other European post-renewal programs

In addition to Austria, Finland, and Luxembourg, several other European countries have adopted and are refining ADT programs. Denmark, for example, introduced a novice driver training program in 1986 and achieved a sustained reduction of crashes of 7% for the first year of solo driving (European Commission, 2007). The highly structured and systematic approach to training in Denmark is based on sound pedagogical principles, and is further evidence of effective ADT. The Commission study section titled "Good Practice Measures" suggests the Danish initial driver training program had attained good practice status. It goes on to state: "The results of the evaluation are considered strong enough to indicate that formal driver training can be rendered more effective through a more structured, educational approach and the systematic linking of theory and practice, and basic driving skills and risk awareness".

A 2004 Norwegian program includes over 30 mandatory lessons with professional driving instructors, self evaluation, and a slippery track risk awareness course. The training focuses on planning, self evaluation based experiences, practicing risky maneuvers, and discussing risky situations. The program also requires high standards for driving instructors, as does the program in Denmark and other previously described programs (European Commission, 2007).

Switzerland introduced a 2nd phase driver training program in 2006. Like other European courses, the Swiss use slippery track training with heavy emphasis on risk awareness and self reflection. It is combined with a driver probationary period (European Commission, 2007).

Discussion and Conclusions

The empirical evidence on ADT programs in the US and most of Europe prior to the mid to late 1990s is consistent, strong, and supportive of abandoning advanced driving education for improving road safety, especially among novice drivers. These 'skills mastery' based courses aim to improve skills of novice drivers, and seem to consistently produce over-confident drivers (see top left of Figure 2). Not surprisingly, the research and/or interest in the US on advanced driving training post licensing programs have waned.

European countries until the mid 1990s had similar experiences to the US (i.e., programs were failing to meet their stated road safety objectives). Study after study confirmed the failure of the European programs. In the mid 1990's, however, fundamentally new approaches were adopted in some European countries which changed the pedagogical approach to driver training. The new methods focus on hazard perception, self monitoring processes, and the impact of risky attitudes and motivations on novice drivers driving. They focus on higher level skills for living and self control rather than low level skills such as controlling speed, direction, and vehicles position.

A review of three European programs based on these 'renewed' pedagogies for ADT show some promise. Each of the three programs reviewed in this paper, analysis of crash data, despite imperfections and some non ideal experimental conditions (e.g. not controlling for confounding factors, programs, etc.), show moderate to strong support for reduced teen driving risk. The Austrian program shows about a 5% reduction in fatal crashes and a 9% reduction in overall crashes among teens over a five year period. Finland's program showed about a 7% reduction over a 6 year period after taking into account crash trends for the entire population. Reductions in slippery road and nighttime crashes were statistically significant in Finland, especially for male drivers aged 21+. Overall, slippery road crashes were reduced by about 23% for participants in Finland's program over a six year period. In Luxembourg, despite relatively low frequencies of crashes compared to other countries, crashes among novice drivers were reduced by about 13% as a result of the ADT program. Denmark's structured program has also shown 7% reduction in crash risk among 1st year novice drivers.

The European Commission (2007) evaluated these same ADT programs in a systematic, rigorous study. The Commission found, after careful review, that numerous programs had demonstrated considerable or at least moderate merit, and deserve further attention. In the report's section titled "Overview of potential future best practice measures", the report cites ADT programs in Denmark, Finland, Austria, Switzerland, and Norway as particularly promising and encouraging, while a large portion of other programs examined were discarded as not meritorious. Many of these advanced driving training programs are too new to have undergone evaluation. The fact that many of these countries have since mandated post-renewal ADT programs suggests that there is at least some belief in program effectiveness, particularly in concert with strict GDL practices implemented in many of the countries.

While the quantitative results based on crashes are encouraging, these are not perfect measures of program 'success' for numerous well known reasons, not the least of which are the issues of potential confounding, sample size, and lack of exposure control raised previously. Some of the evidence from surveys of the programs suggest that the programs are not accomplishing what they intended. Drivers reported engaging in more aggressive driving, and also reported improved self perceived skills. Since the pedagogy is an important stated difference of these programs, additional study is needed to measure and assess the behavioral and psychological aspects of the programs, both short and long term.

The European countries with renewed ADT programs, moreover, have a critical role to play in making details and results of these programs more widely known and providing impetus to continued implementation and refinement of these programs. Given the consistently positive but non-ideal analyses conducted on these programs, a first order priority should be the conduct of controlled studies, either retrospectively or prospectively, to put to rest uncertainty surrounding the current literature. Issues involved with confounded variables, lack of control for exposure before and after implementation, and small sample sizes should be remedied. Careful evaluations of these programs moving forward need to be conducted, translated, and reported in the peer reviewed safety literature. Much can be learned from successes and failures, but only through dissemination of results. These studies need to be carried out with US researcher involvement so that the information and content of these programs can be exported.

If further well controlled studies reveal even a modest but positive effect of these programs the impact could be significant. The estimated effectiveness of European ADT programs ranged from about 5% to 13% based on initial studies. Given the current number of novice drivers killed in the US annually, these estimates suggest a savings of between approximately 400 to 900 teenage lives per year. Using Blincoe et al. (2000) to estimate the benefit of these savings, and recognizing the limitations on the valuation of human life, the range of savings per year based on an estimated $3,366,388 per life saved (and assuming the European outcomes represent a plausible range) is between 1.34 and 3.0 billion US dollars annually. If injuries are considered, and fatal costs are 17.7% of total crash costs (see Blincoe, 2000), the estimates of cost savings increase to between $7.57 and $16.9 billion per year. Even half the lowest estimate of effectiveness—2.5%, could save approximately $3.7 billion annually.

Should further study substantiate even modest effectiveness of these programs, initiatives should be taken to explore these potentially fruitful programs in the US. Recognizing the differences between the driving cultures, driving age, levels of motorization, enforcement practices, adjudication, licensing programs, cost of travel, etc. across the countries examined in this paper, the basic elements of driving, such as perceiving, reacting, and assessing risk, should be generally transferable across countries. The pedagogical approach embraced by the European post-renewal programs seems to directly address the main concerns raised about pre-renewal programs in the US and abroad (e.g., concerns thought to explain the poor performance of these programs), at least in principal. Moreover, post-renewal ADT programs do not compromise mobility, unlike strict GDL practices, which can face opposition due to reduced mobility of such programs, making ADT programs more politically palatable by comparison.

If such a program is piloted in the US numerous issues need to be considered. A program should be designed to carefully evaluate and measure its effects—the profession is littered with too many failed attempts with advanced driver training programs. Participants and a control group should be monitored and evaluated for a sufficient period of time to measure sustained program effects. A subset of participants in a US program should be selected randomly so as to negate any potential regression to the mean bias as the result of incentives to improve during the post training driving

record, as the program will not be mandatory. Finally, a pilot program should based on the new pedagogy emerging in Europe, and then after testing, be evaluated and refined to accommodate the US driving population by leveraging expert knowledge from both European experience and US experts. The pedagogy must consider unsafe driver behavior and motivation, motivation of instructors and examiners, and account for key differences between European and US licensing, driver training, and driver education.

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